Chapter 2 Designing a Water Study

The first step in developing a water study design is identifying your watershed. The ability of a stream to support beneficial uses such as fishing, boating and swimming is influenced by the major land uses in the watershed, the nature of the stream channel, the diversity of instream habitats, and the character of the riparian area.

Identifying Your Watershed

The watershed is the total area of land that drains into a particular waterbody (wetland, stream, river, lake, or sea). Land uses and runoff in a watershed determine the quality of surface water in smaller streams and waterways. They can then influence the water quality of larger streams. For example, point source discharges, urban runoff, runoff from landfills and runoff from agricultural areas may contain sediments, organic material, nutrients, toxic substances, bacteria or other contaminants. When these substances are present in significant concentrations, they may interfere with some stream uses.

Approximately one percent of a watershed is stream channels. The smallest channels in a watershed have no tributaries and are called first-order streams. When two first-order streams join, they form a second-order stream. When two second-order streams join, a third order stream is formed, and so on. First and second-order channels are often small, steep or intermittent. Stream orders that are six or greater constitute large rivers (See Figure 2).

The stream channel is formed by runoff from the watershed as it flows across the surface of the ground following the path of least resistance. The shape of the channel and velocity of flow are determined by the terrain, unless changes have been made by man. When the terrain is steep, the swiftly moving water may cut a deep stream channel and keep the streambed free of sediments. In flatter areas, the stream may be shallow and meandering, with a substrate comprised largely of fine sediments.

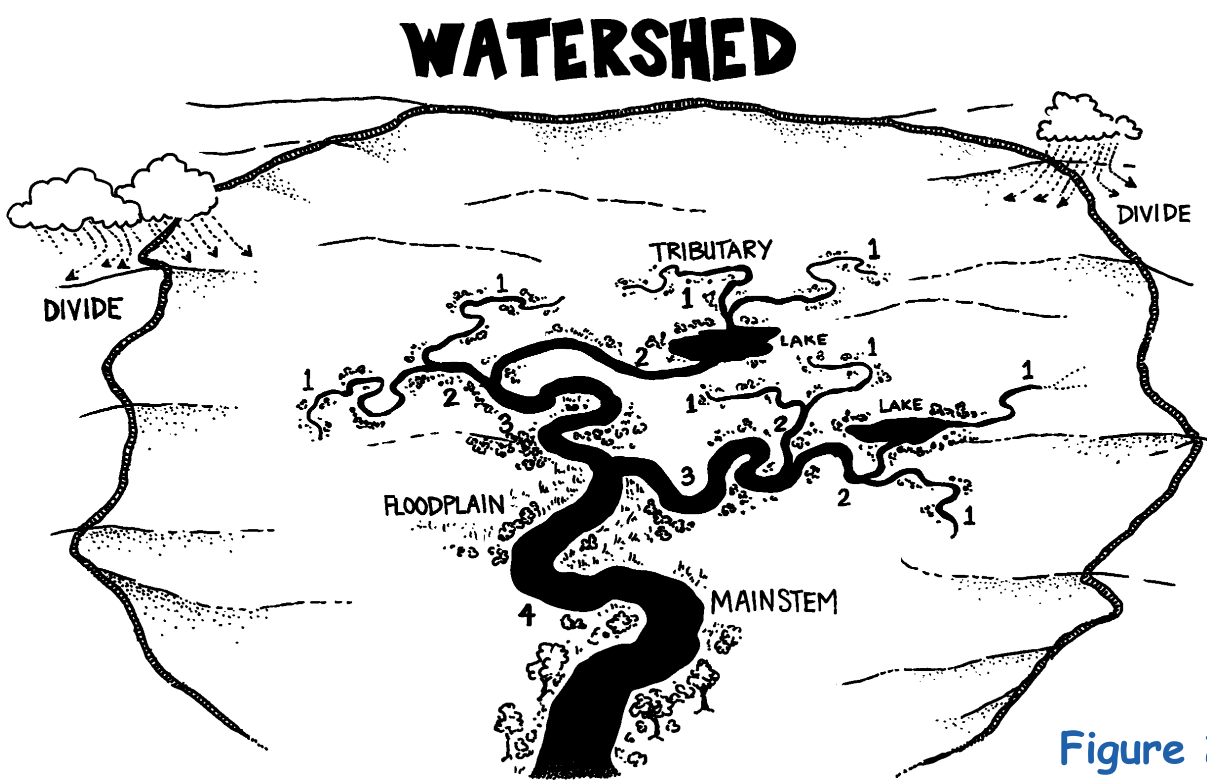


Figure 2

What is Your Watershed Address?

Hydrologic Unit Code Areas

Knowing your "watershed address" is very important to understanding the influences on the water quality in your stream or river. Hoosier Riverwatch organizes data from volunteer stream monitors by watershed location using the map: "Indiana Watersheds: 8-Digit Hydrologic Unit Code Areas" (See Figure 4 on the next page). Delineated by the U.S. Geological Survey, hydrologic units represent the geographic boundaries of water as it flows across the landscape. But not every HUC is a "watershed" in the pure sense, since longer streams are divided along their length. As you can see on the map, each HUC has an associated 8-digit number or code. This number is representative of the size of the basin. Larger basins are represented by smaller numbers. Look at the first six numbers of two or more watersheds near each other on the map; if they are the same (e.g. Chicago, Kankakee, and Iroquois in northwest Indiana, which are 071200), then they are part of the same larger watershed. You could use colored pencils to delineate these larger watershed boundaries on this map.

Check the map on page 9 and write your watershed address here:

Watershed Name ______________________ **Watershed #**__ __ __ __ __ __ __ __

Water within watersheds beginning with "04" flow into Lake Michigan or Lake Erie and are part of the Great Lakes Watershed. The "07"s flow west into the Illinois River before entering the Mississippi River. Water from the "05" watersheds flows into the Wabash or Ohio Rivers before also joining the Mississippi River and discharging into the Gulf of Mexico. The Mississippi River watershed is the largest in the United States (See Figure 3 below).

Indiana is divided into 39 watersheds at the 8-digit level. Each of these watersheds can also be divided into smaller sub-watersheds which are represented by 11-digit numbers, and even smaller units with 14-digit numbers. Your local Natural Resources Conservation Service (NRCS) office can provide you with a copy of the watersheds in your county.

Mississippi River Watershed

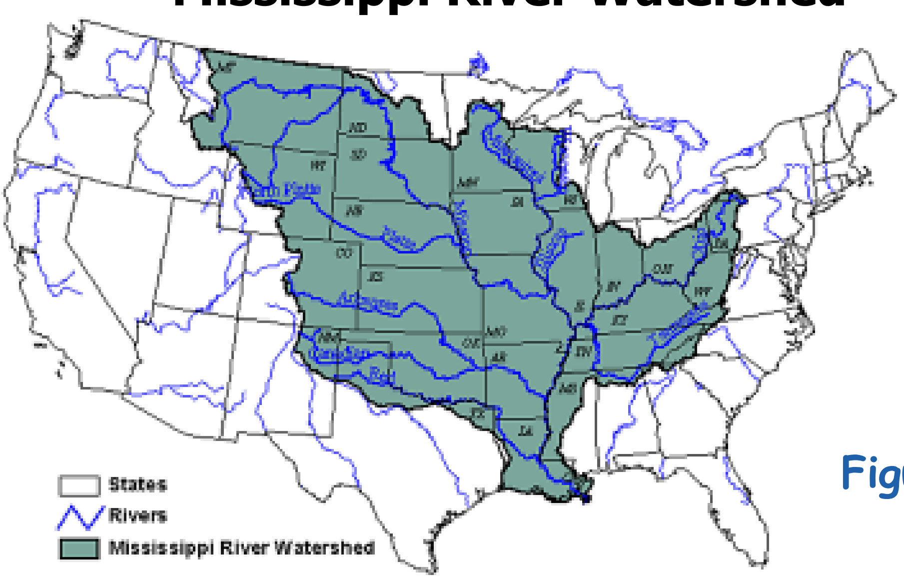
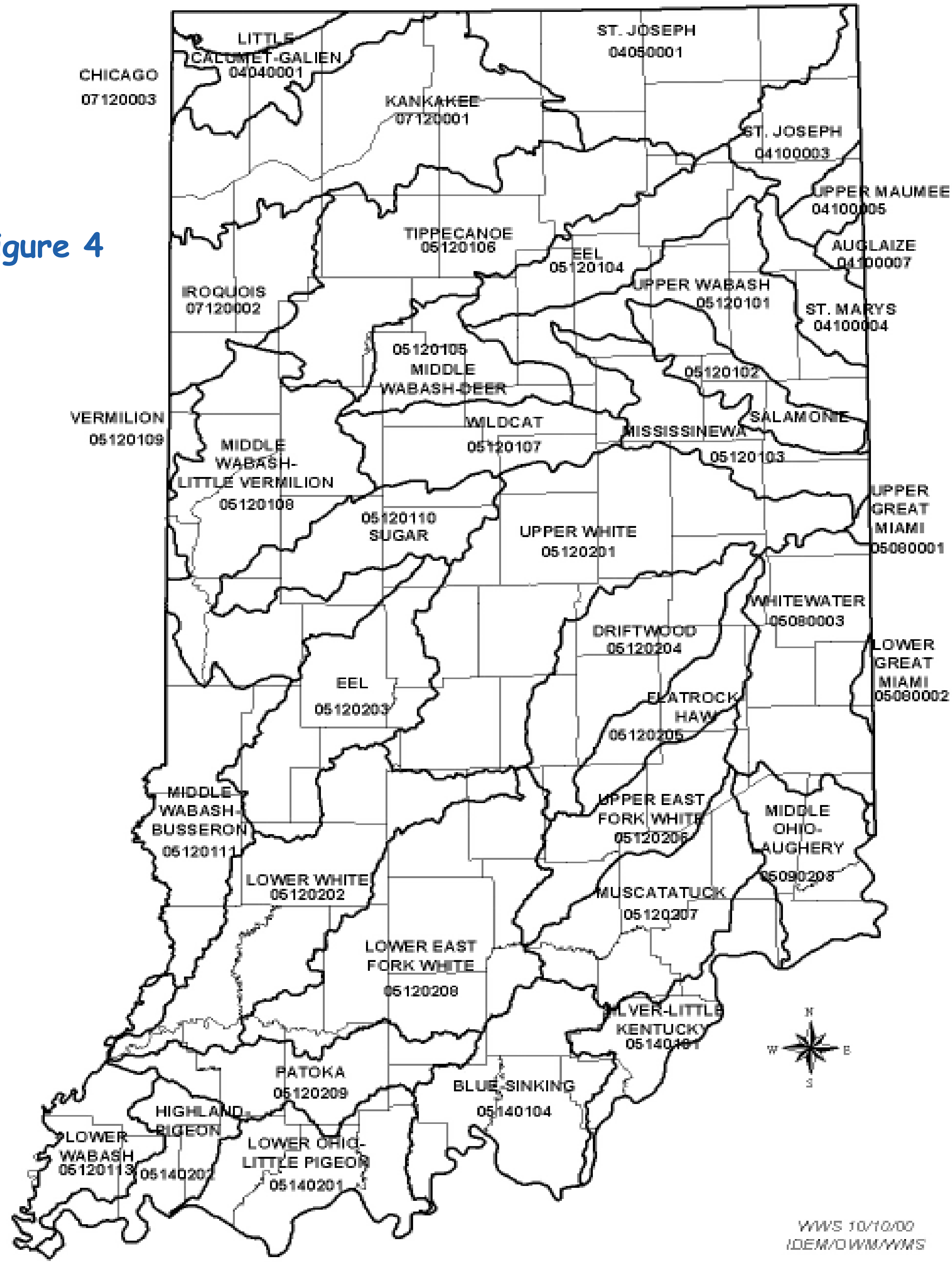


Figure 3

8 - Digit Hydrologic Unit Code Areas in Indiana

Figure 4



Indiana's Ten Major Watersheds

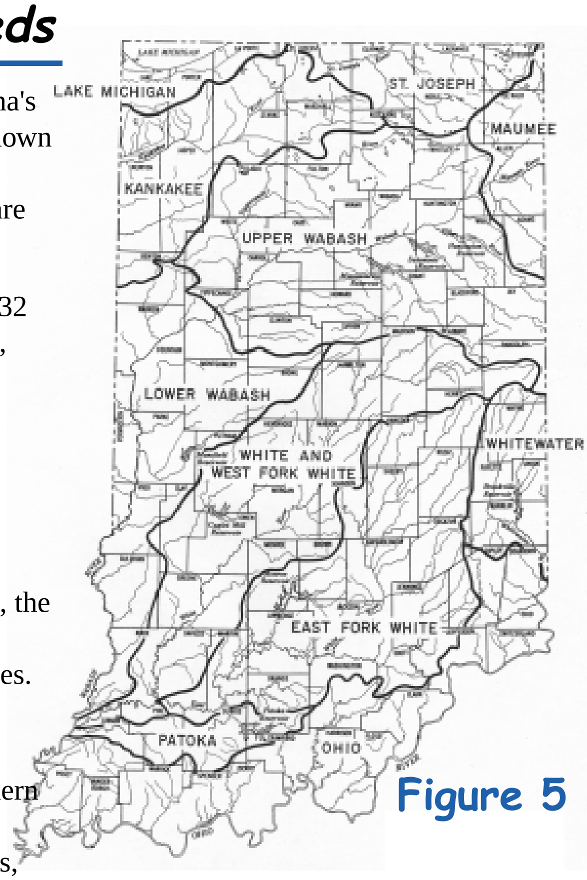


Figure 5

This section provides basic background information on Indiana's major watersheds. The water management drainage basins shown in Figure 5 are also a rough delineation of the "six-digit watersheds" from the 8-Digit map. These six-digit numbers are provided next to each watershed name.

The State of Indiana has a surface area of approximately 36,532 square miles. There are about 90,000 miles of rivers, streams, ditches and drainage ways in Indiana. In addition, there are approximately 35,673 miles of surface waterways in Indiana greater than one mile in length.

Lake Michigan Basin (040400)

The Lake Michigan Basin includes four major waterways in Indiana: the Grand Calumet River-Indiana Harbor Ship Canal, the Little Calumet River, Trail Creek and the St. Joseph River. It drains portions of Lake, LaPorte, Porter and St. Joseph counties.

St. Joseph River Basin (040500)

The St. Joseph River Basin drains 1,699 square miles in northern Indiana and 2,586 square miles in southern Michigan. The Indiana section contains a unique combination of natural lakes, wetlands, streams with well-sustained flows and extensive sand and gravel aquifer systems. It drains parts of Steuben, DeKalb, LaGrange, Noble, Elkhart, Kosciusko, and St. Joseph counties. The major tributaries of the St. Joseph River are: the Elkhart River, Pigeon River, Fawn River, North Branch Elkhart River, Turkey Creek, Little Elkhart River, Christiana Creek, and South Branch Elkhart River.

Kankakee River Basin (071200)

The Kankakee River Basin drains about 3000 square miles of northern Indiana before flowing westward into Illinois and the Illinois River. It drains portions of Lake, Porter, LaPorte, St. Joseph, Marshall, Starke, Pulaski, Jasper, Newton, Benton, White and Elkhart counties. Major tributaries in Indiana include the Iroquois and Yellow Rivers. The largest cities in the watershed are LaPorte and Plymouth. Many of the present characteristics of the Kankakee Basin restulted from the geologic history of the area. Glaciers flattened the region, and moraines formed by melting ice made the basin lower than surrounding areas. Sand was deposited in this low area by the melting glacier, and much of this lowland became a gigantic marsh, which is now artificially drained. Today, most of the streams in the basin have been dredged and straightened. Most of the streamflow is made up of groundwater, providing a relatively constant discharge of cool water throughout the year.

Wabash River Basin (051201)

The Wabash River Basin is the largest designated drainage basin and is divided into upper, middle, and lower portions. The Basin drains approximately 33,000 square miles of Illinois, Indiana, and Ohio. The greatest portion of the basin is in Indiana where it drains two-thirds of the state. The Upper Basin drains portions of Kosciusko, Noble, Whitley, Allen, Wells, Wabash, Huntington, Grant, Blackford, Jay, Randolph, Delaware, Fulton, Marshall, Miami, Pulaski, Howard, Cass, Tipton, Clinton, Tippecanoe, White, Carroll, and Starke counties. The Middle Basin drains portions of Benton, White, Tippecanoe, Clinton, Boone, Montgomery, Warren, Fountain, Putnam, Parke, Vermillion, Vigo, and Clay counties. The Lower Basin drains portions of Vigo, Clay, Sullivan, Greene, and Knox counties.

Maumee River Basin (041000)

The Maumee River Basin is located in northeastern Indiana and drains portions of Adams, Allen, DeKalb, Noble, Steuben and Wells counties. The Maumee River drainage area within Indiana is approximately 1,283 square miles. The Basin is comprised of three major rivers: the St. Joseph, the St. Mary's and the Maumee. The Maumee River originates in Fort Wayne at the confluence of the St. Joseph and St. Mary's Rivers. It then flows east into Ohio where it crosses the northern portion of the state toward Toledo and empties into Lake Erie.

West Fork of the White River Basin (051202)

The West Fork of the White River begins near Winchester in Randolph county, Indiana and flows through 11 counties where it is joined by the East Fork of the White River near Petersburg. It drains portions of Randolph, Henry, Delaware, Madison, Hancock, Brown, Monroe, Owen, Greene, Martin, Daviess, Knox, Clay, Pike, Gibson, Clinton, Vigo, Tipton, Boone, Hendricks, Putnam, Morgan, Johnson, Hamilton, Marion, and Sullivan counties. The main stem of the White River then flows about 48 miles and joins the Wabash River. In total, the West Fork flows about 356 river miles and drains 5,600 square miles of land in Indiana.

East Fork of the White River Basin (051202)

The East Fork of the White River Basin drains approximately 5,600 square miles of Southern Indiana. Sugar Creek, Big Blue River, Driftwood River, Flatrock River, Muscatatuck River, and Salt Creek are the river's major tributaries. The basin drains portions of Henry, Hancock, Rush, Fayette, Shelby, Johnson, Brown, Bartholomew, Decatur, Jennings, Ripley, Jefferson, Scott, Washington, Orange, Jackson, Lawrence, Martin, Daviess, Dubois, Pike, Brown, Monroe, Greene, and Marion counties. The largest cities in the watershed are Columbus, Seymour, Bloomington, New Castle, Shelbyville, and Bedford. The topography of this basin ranges from flat to rugged as it crosses seven of Indiana's eight physiographic regions. The basin also includes unique underground streams in the karst region of Orange and Lawrence counties. The groundwater contribution to stream flow in the basin is low, so flow depends largely on rainfall and variations can be considerable. Compared to several other basins, stream channelization projects in the East Fork of the White River have been minimal.

Whitewater River Basin (050800)

The Whitewater River Basin drains 1,403 square miles in Indiana. It begins in Randolph county where it flows south through Connersville and then takes a southeasterly course into Ohio and empties in the Ohio River. It drains parts of Wayne, Fayette, Union, Franklin, Randolph, Henry, Rush, Decatur, and Ripley counties.

Patoka River Basin (051202)

The Patoka River Basin drains 862 square miles within a long, narrow basin in southwestern Indiana. The basin is approximately 12 to 16 miles wide throughout most of its 78 mile length. The Patoka River begins in the Patoka Reservoir which lies in parts of Dubois and Crawford counties, but mainly Orange county. The river flows through Dubois, Pike and Gibson counties and empties into the Wabash River.

Ohio River Basin (051401, 051402, 050902)

The Ohio River and its Indiana tributaries (excluding the Wabash River) drain approximately 5,800 square miles in Indiana. The major Indiana tributaries in the basin are: the Whitewater River, Blue River, Little Blue River, Anderson River, Laughery Creek, Big Indian Creek, and Pigeon Creek. The basin drains portions of Dubois, Posey, Vanderburgh, Warrick, Spencer, Perry, Dearborn, Ripley, Decatur, Franklin, Ohio, Switzerland, Jefferson, Clark, Floyd, Harrison, Scott, Washington, Orange, Crawford, and Gibson counties.

What is Water Pollution and Where Does it Come From?

Many volunteers monitor because they are concerned about pollution. Volunteer monitors check for current pollution and develop a baseline to gauge future pollution. Water pollution can typically be placed in one of two categories: point or nonpoint source pollution. Point source pollution is easy to identify because it is discharged from the end of a pipe. It accounts for about 25% of all water pollution. Point sources are regulated with permits by the Indiana Department of Environmental Management.

Nonpoint source pollution originates primarily from runoff and is more difficult to identify. It is a product of land use throughout the entire watershed, and makes up about 75% of water pollution. Different types of pollution are described below and shown in Figure 6.

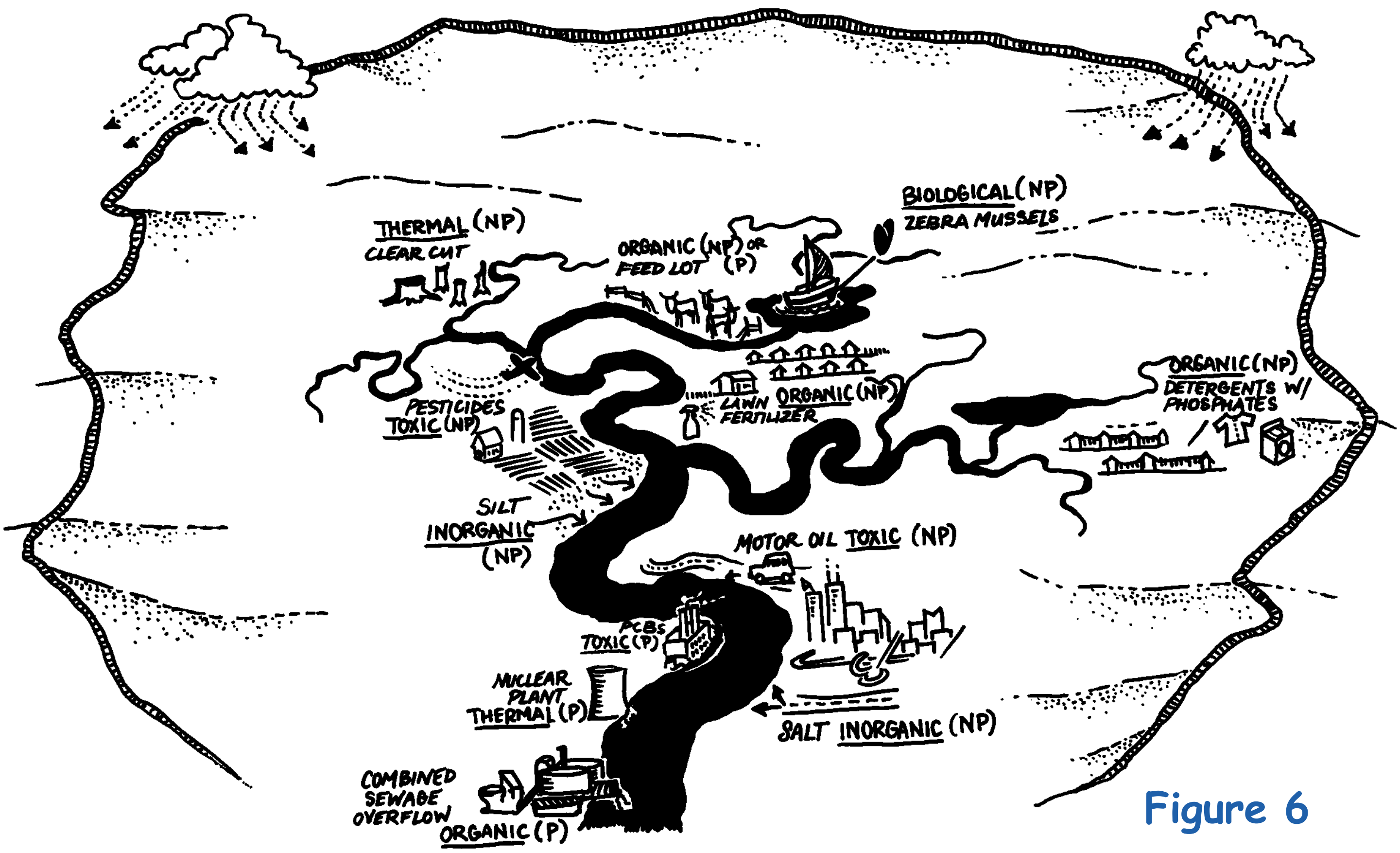


Figure 6

Point sources are indicated by a "P"; nonpoint sources are "NP."

1. **Organic Pollution** - decomposition of once-living plant and animal materials
2. **Inorganic Pollution** - suspended and dissolved solids (e.g. silt, salt, minerals)
3. **Toxic Pollution** - heavy metals and lethal organic compounds (e.g. iron, mercury, lead, PCB's) - some of these are transferred via the atmosphere and air deposition
4. **Thermal Pollution** - heated water from runoff (e.g. streets, parking lots) or point source discharges (e.g. industries, nuclear or other power plant discharges)
5. **Biological Pollution** - introduction of non-native species (e.g. zebra mussels, purple loosestrife, Eurasian Water Milfoil)

1 Source of Water Pollution by Volume to Indiana Streams and Rivers is **Sediment**!

Soil erosion and sediment as a result of poor construction, logging, landscaping, and agricultural practices, as well as eroding stream banks, cause many physical changes in streams that lead to decreased water quality.

Physical Changes in Streams Affected by Sediment	Resulting Direct and Indirect Effects on Aquatic Organisms
Heat is absorbed resulting in increased water temperature	Metabolic rates of organisms increases → wasted energy not available for growth and reproduction
Water clarity is decreased → turbidity is increased Increased siltation and embeddedness on stream bottom (Figure 7)	Reduction in visual feeding and visual mating Clogging of gills during breathing and feeding Smothering of nests and eggs Change in habitat, and filling of crevices in bottom gravel
Excess organic debris is carried with soil → may result in increased biochemical oxygen demand and decreased dissolved oxygen	Oxygen sensitive species are detrimentally affected pH is reduced (water becomes more acidic) resulting in: Phosphorus becoming more available Ammonia becoming more toxic More leaching of heavy metals
Excess phosphorus is attached to soil particles and is carried into streams	Phosphorus acts as a 'fertilizer' Algal growth increases → higher daytime dissolved oxygen & lower nighttime dissolved oxygen Can upset normal feeding on the aquatic food chain
Heavy metals may be leached from soil → increased toxicity	Developmental deformities Behavioral changes in feeding, mate attraction and activity, and parental care

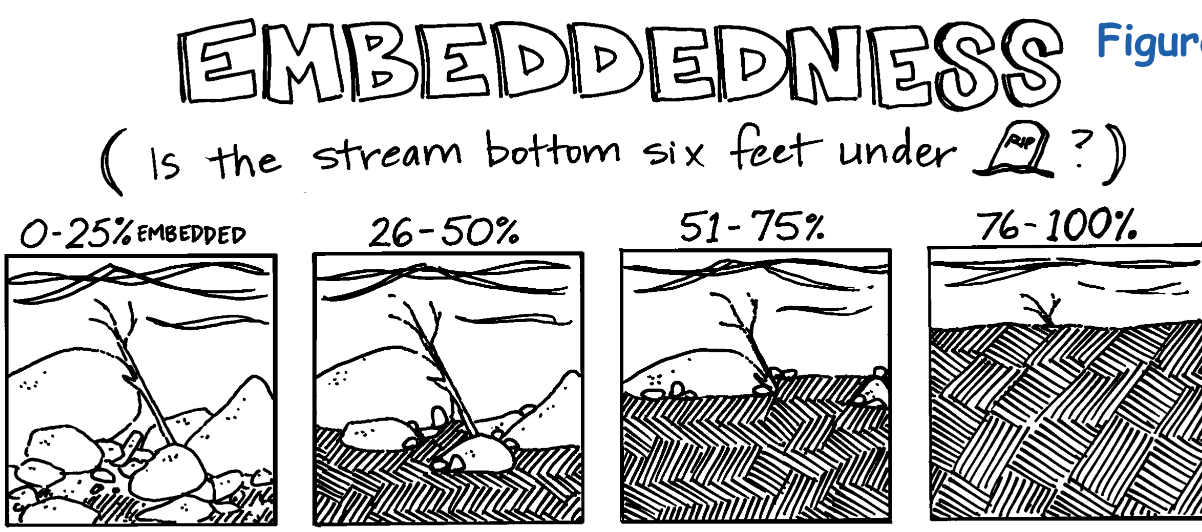


Figure 7

Watershed Inventory

Information in this section is reprinted and modified from *Hudson Basin River Watch Manual*, **Ohio EPA Explore Your Stream (EYS), and the** ***IOWATER Program Handbook.***

We know where water pollution might originate, now it's time to take a look around your watershed and discover the potential pollution sources there. The purpose of a watershed inventory is to learn about the current uses, values, and threats to the water resources in your watershed. In general, there are two ways to gather information:

Research: Use maps and aerial photos; Get copies of existing reports; Find out the designated uses; Identify your river's special attributes and threats to these uses and values; Survey people; Know what municipalities govern your watershed.

Field Inventory: No matter how much information you discover through your research, the best way to know what's really going on is to get out into the field. You can perform a driving survey or "windshield tour" and also get out of your vehicle and take a look around (respecting private property rights, of course)! What should you be looking for? ANYTHING that may affect your stream.

Land Uses

- ❑ **Agricultural Crops/Fields -** Using conservation buffers? (See page C-2 for more info.)
- ❑ **Pasture/Livestock -** Manure management system? Is waterway protected with fences?
- ❑ **Logging -** Are there clear-cuts (all trees) or selective cuts of individual trees? Are Best Management Practices in place? (See page C-2 for more info.)
- ❑ **Mining -** What kind: surface, underground, quarry? Is it active, abandoned, reclaimed?
- ❑ **Waste Disposal -** Landfills, home septic systems, sewers, pet waste
- ❑ **Construction Areas:** Homes/buildings, roads, bridges - Are Best Management Practices in place?
- ❑ **Residential/Suburban -** Storm drains, lawns, commercial businesses (malls/strip malls, retail shops, car wash, gas stations, restaurants)
- ❑ **Urban -** Drinking water/waste water treatment facilities, factories, power plants
- ❑ **Recreation Areas** (Zoo, forests, nature preserves, parks, greenways, campgrounds, golf courses, hiking and horseback trails, swimming areas, fishing areas, power boating)

This list is just a few things to look for and is not a complete list. It's meant to start you "down the road" considering what is in your own watershed and what may impact your water quality as you begin your water study. The information collected during your watershed inventory is for your use only - but it is strongly recommended that you consider doing it at the beginning of your monitoring!

Instream Conditions

- ❑ **Litter/Garbage -** small litter, piles of trash, illegal dump, appliances
- ❑ **Algae -** floating, attached, color
- ❑ **Water Color -** clear, muddy, milky, tea-colored, red, gray, green, black
- ❑ **Water Appearance -** oily sheen, lots of foam/bubbles, scum
- ❑ **Water Odor -** sewage, petroleum (gas), rotten eggs, fishy, chlorine, soapy
- ❑ **Discharge Pipes -** field tiles, storm drain, industry, municipal wastewater, sewer, other

Setting Goals

A very important step in designing a water study involves identifying your reasons for monitoring water quality. Deciding on your study goals will help streamline the process of designing your study and will help ensure a successful outcome. To determine your goals, ask yourself and the members of your group: **Why are we undertaking this project and what do we hope to accomplish?**

Initially, your goals may be relatively simple and straighforward:

- Is the water safe for recreational activities (swimming, wading or boating)?

But over time, the knowledge you gain may prompt you to ask bigger questions and may even prompt you to take action in your watershed:

- Is the stream ecosystem being impacted by a pollution source? What are the sources of pollution?
- How can we decrease or eliminate one or more sources of pollution and thereby positively impact our watershed?

Goals will differ for every group depending upon individual interests. Following are examples of different types of goals that may apply to Hoosier Riverwatch volunteers *(modified from the GREEN Standard Water Monitoring Kit Manual):*

What are Your Environmental Goals?

Volunteers will:

- become familiar with the river ecosystem;
- learn to recognize water quality problems and their sources;
- understand relationships between land use and water quality;
- make a responsible, action-oriented contribution toward protecting the river and watershed.

What are Your Community Goals?

The community will:

- assist volunteers with water quality data collection;
- contribute resources such as maps, water quality testing equipment, computers for data entry;

Volunteers will:

- develop an awareness and responsibility to their watershed as an individual and as a community;
- communicate findings and the results of their actions to the community.

What are Your Educational Goals?

Volunteers will:

- plan, implement and analyze a scientific investigation;
- develop field skills necessary for water quality testing;
- strengthen observational, analytical and problem-solving skills;
- compile and compare water quality data;
- use and integrate several disciplines (chemistry, biology, geography, language arts, math, etc.).

Remember – no matter what your goal for monitoring, any water study must be founded on sound, scientific, and objective research!

Planning a Water Study

The final step in developing a water study design is actually planning the river or stream study. This involves choosing your sampling site(s), setting a sampling schedule and organizing your volunteers or students.

Site Selection

Before you select one or more sites it's important to research, visit, and learn about your watershed, land uses, and potential sources of pollution. Selection of your sampling site(s) depend upon your individual goals and interests. If you are interested in the affects of agriculture on water quality, you may want to sample a stream with a primarily agricultural watershed. If you want to determine the affects of industrial discharge on stream water quality, you may choose to monitor at three points, one upstream (control site), immediately below the source, and one further downstream to gauge recovery. It's up to you to choose where you would like to monitor! If you need help choosing a spot, your county Soil and Water Conservation District may have some suggestions. A watershed management plan may be in development in your community. In addition, you can contact Hoosier Riverwatch for a list of sites requested by the Indiana Department of Environmental Management related to monitoring for their Total Maximum Daily Loads (TMDL) program.

Each sampling site is 200 feet in length!

Each sampling site is a 200-foot stream segment. You should use local landmarks (bridges, trees) or survey tape to define the boundaries of your sampling site. You might also want to sketch your site (see page 26). You must also ensure safety by considering bank accessibility, water depth, and private property rights. Review the Safety section (Chapter 1) for other important safety considerations.

Sampling Schedule

Finally, make a sampling schedule. Consider how many people will be monitoring, how many sites you or your group plan to sample, and whether sampling is feasible year-round (e.g., due to drought, flooding, or ice cover). Think about the types of tests you will perform, the time requirements, and the goals you have set. Many Riverwatch groups monitor four times a year, but if sampling can only be done once or twice a year, it is preferable to do it in early spring and fall. You may also want to consider sampling at least once during or after a storm event to gauge impacts from stormwater runoff. A written schedule will help you organize yourself and/or your group. (*Add monitoring events to your calendar, planner, or Palm Pilot/PDA!*)

Groups of Students or Adults

Measurements can be taken by groups of 2-3 students or adults. Tasks within a group include collecting samples, processing samples, and recording data. It is very useful to have multiple groups testing for each parameter (for example, two groups measure dissolved oxygen). This allows more participants to get involved and builds in some quality control. Groups conducting the same test should compare results to determine if the data are similar. If there are different results for the same sample, group members should check the procedures and repeat the test to determine the cause of the difference. **Quality control is an important part of the science and the learning experience!**

Quality Assurance and Quality Control

Many volunteers strive to obtain the best data possible. We think this is important, as YOU are one of the primary users of the data. The following are some suggestions on how you can improve the quality of your water monitoring data.

A quality assurance and quality control (QA/QC) plan can help ensure that test results are as accurate and precise as possible. Accuracy refers to how close a measurement is to the true value. Precision means the ability to obtain consistent results. Reliability in both accuracy and precision is achieved by:

- Collecting the water sample as directed
- Rinsing bottles and tubes with sample water *before* collecting the sample and with distilled water *after* completing the test
- Performing tests immediately after collecting the water sample
- Careful use and maintenance of testing equipment (check by using blanks and standards)
- Following the specific directions of a testing protocol exactly as described
- Repeating measurements to check for accuracy and to understand any sources of error
- Minimizing contamination of stock chemicals and testing equipment
- Storing kits away from heat and sunlight
- Checking expiration dates on chemicals and replacing them *before* they expire
- Checking to be sure the results submitted to the Hoosier Riverwatch database are the same as those recorded on the data sheets.

Repeated Measurements

By repeating measurements, volunteers collect better data. Streams and rivers are variable. The water flowing past a point in the stream constantly changes. Taking <u>multiple measurements</u> and <u>averaging the values</u> captures some of the natural variation and provides a more representative result. In addition, taking more than one measurement reduces the chance of reporting incorrect data. If more than one person and/or testing kit are used, replicates provide an opportunity to test for both operator error and bad reagents. If one person obtains a value considerably different from another, repeat the test. If you are working with a group of student or adult volunteers, the purchase of a few additional items for chemical and biological monitoring (e.g., nets, color comparators) will improve efficiency in performing replicates.

However, given the cost of CHEMetrics ampoules and Water Works test strips and the <u>low sensitivity</u> of these methods, most Riverwatch volunteers will only perform each of these measurements one time.

Standards, Blanks and Splits

A standard is a sample of known concentration. Standards can be purchased from Hach or other chemical companies. A blank is a sample run using distilled water. By testing standards and blanks, volunteers can check for bad reagents and equipment contamination. A split is one sample tested twice (for example, two nitrate tests preformed out of the same bucket of water taken from a stream). Splits test for operator error, as both tests should yield the same result.

A Few More Details Before We Get Started...

Volunteer Monitoring Network

There is no national volunteer water quality monitoring program, but many states have a statewide program with their own set of parameters and methods. Our neighboring states, Ohio, Illinois, Kentucky, and Wisconsin have statewide volunteer stream and river monitoring programs. However, Hoosier Riverwatch has many state and national partners with whom we collaborate; we are truly part of something bigger!

Hoosier Riverwatch is housed at the Natural Resources Education Center (NREC) at Fort Harrison State Park in Indianapolis. We share facilities and partner with the Indiana Department of Natural Resources' statewide education programs: Go FishIN, Project Learning Tree, Project WET (Water Education for Teachers), and Project WILD. In addition, we work closely with Earth Force, a national nonprofit organization, and we are helping to implement their GREEN (Global Rivers Environmental Education Network) program in Indiana schools. We are also a member of River Network and have contributed to the national River Rally conference for the past few years.

What You Can Expect From Hoosier Riverwatch

What is Hoosier Riverwatch's role in our partnership with you? Our primary responsibilities are to provide hands-on training, water monitoring equipment, ongoing technical support, information and education, and maintenance of the Online Volunteer Stream Monitoring Database. Our job is to empower you, to provide you with help and support to monitor Indiana's water quality, and to help you find solutions to problems if the arise.

Riverwatch Wouldn't Exist Without You

You have the freedom to monitor whenever and wherever (with permission from private property owners, of course!) you chose. These decisions are guided by your reasons for monitoring. And remember, YOU are the primary user of the data you collect. It is possible that your data may be used by others (e.g., Indiana Department of Environmental Management, consultants, universities, local governmental agencies and watershed groups), but do not count on someone else "doing something" with your data. YOU will likely need to initiate action if you want to see solutions. However, the only way your data can be utilized by these entities is by submitting it to our Online Database (see Chapter 7) and registering your exact site location (latitude and longitude).

Preparation for Participation

You're going to learn a lot of new information as you attend a Riverwatch training workshop or read through this training manual on your own. You may feel a little overwhelmed with new information at times. But, we guarantee that with some <u>advanced preparation</u> (e.g., planning, scheduling, financing, networking, gaining permission, and possibly getting through a little red tape) and <u>practice</u> with the equipment and data sheets, any educator, community group, or interested citizen can really make a difference by participating in this program.

> Take a deep breath & relax! You will be fine!
> SMILE - this stuff is fun!
>
> We truly hope you will enjoy the training and information and will put what you learn into practice!